

**POWER TRANSFORMER AGREEMENT**

**ABB INC.**

**and**

**NATIONAL GRID USA COMPANIES**

**NEW YORK P.O.# CC99078BWD**

**NEW ENGLAND P.O.# C101629**

**POWER TRANSFORMER AGREEMENT  
LLA-003-03**

**SCHEDULE A  
SPECIFICATION T-001-03-SFU**

**345/115 KV & 230/115 KV  
AUTOTRANSFORMERS**

**FOR**

**NEW ENGLAND POWER COMPANY  
NIAGARA MOHAWK POWER CORPORATION  
AND  
THE NARRAGANSETT ELECTRIC COMPANY**



**National Grid**

**SCHEDULE A**  
**POWER TRANSFORMER SPECIFICATION**  
**NO. T-001-03-SFU**

**AUTOTRANSFORMERS**

**Rated MVA: (See Table Below)**  
**Rated Voltage: (See Table Below)**

**Company: (See Table Below)**  
**Substation: (See Table Below)**

**Project Description**

The step up and step down autotransformers tabulated below will be used for transmission substations. The autotransformers shall be oil immersed, three phase (except as noted), 60 Hz, suitable for outdoor installation and continuous operation at 65°C rise.

<b><u>Part:</u></b>	<b><u>Company</u></b>	<b><u>Substation</u></b>	<b><u>Address</u></b>	<b><u>Voltage (kV)</u></b>	<b><u>MVA Rating</u></b>
A-1	New England Power	NE Spare	Stored at Sandy Pond Substation Westford Rd., Ayer, MA	345 / 115	268.8 / 358 / 448
A-1	New England Power	Ward Hill	48 Cross Rd., Haverhill, MA	345 / 115	268.8 / 358 / 448
A-1	New England Power	Wachusett	53 Temple St., West Boylston, MA	345 / 115	268.8 / 358 / 448
A-1	New England Power	Wachusett	53 Temple St., West Boylston, MA	345 / 115	268.8 / 358 / 448
A-1	Narragansett Electric	Kent County	700 Cowesett Rd. Warwick, RI	345 / 115	268.8 / 358 / 448
A-2	Niagara Mohawk	NY Spare	Stored at Henry Clay Service Center 7437 Henry Clay Blvd., Liverpool, NY	345 / 120, LTC	268.8 / 358 / 448
A-3	Niagara Mohawk and New England Power	NY/NE Spare	Site to be determined	230 / 115, LTC	200 / 267 / 333
A-4	Niagara Mohawk	Packard	1650 New Rd., Niagara Falls, NY	230 / 115, LTC	75 / 100 / 125
A-5	New England Power	Tewksbury	357 Old Boston Rd., Tewksbury, MA	230 / 115	100 / 133 / 167, 1Ø
A-6	New England Power	Pratt's Jct.	26 Pratt's Jct. Rd., Sterling, MA	230 / 115	90 / 120 / 150

## SCHEDULE A

### POWER TRANSFORMER SPECIFICATION

#### SECTION II - PART A-1: TECHNICAL REQUIREMENTS

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##### PURPOSE

The intent of this section is to describe the technical requirements of the transformer and associated ancillary equipment. The detail and description of the ancillary equipment referred to in this section are given in SECTION II - PART B of this specification.

##### TABLE OF CONTENTS

<u>Item</u>	<u>Description</u>
1.	Quantity
2.	Rating
3.	Angular Displacement
4.	Additional Full Capacity Taps
5.	Winding Insulation
6.	Impedance
7.	Positive and Zero Sequence Equivalent Circuit
8.	Sound Level
9.	Losses
10.	Bushings
11.	Bushing Current Transformers
12.	Surge Arresters
13.	Auxiliary Power Source
14.	Bushing Arrangement
15.	Additional Requirements
	Figures

### 1.0 Quantity

Number of Autotransformers: Five

### 2.0 Rating (Performance guarantee)

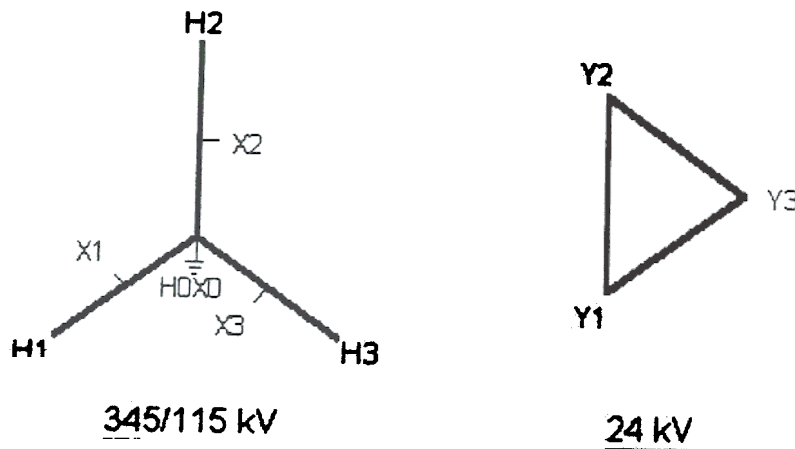
2. This step-up and step-down autotransformer will be used for a transmission substation. The autotransformer shall be oil immersed, three-phase, 60 Hz, suitable for outdoor installation and guaranteed continuous operation at 65°C rise as follows:

<u>Winding</u>	<u>MVA</u>	<u>Voltage (kV)</u>
<u>High Voltage</u>	<u>268.8 / 358 / 448</u>	<u>345 (Grd. Y) / 199.2</u>
<u>Low Voltage</u>	<u>268.8 / 358 / 448</u>	<u>115 (Grd. Y) / 66.4</u>
2.1.3 <u>Tertiary Voltage</u>	<u>25 / 33.3 / 41.8</u>	<u>24 (Delta)</u>

- 2.2 The autotransformer shall be suitable for simultaneous three winding operation provided that the MVA rating of any winding is not exceeded. Tertiary capacity specified above is for potential use by the Purchaser and is not intended as a specification for the overall rating of the tertiary winding.
- 2.3 The Seller shall guarantee the autotransformer overload capability specified in Schedule A, Section I, Item 4.0, of this specification. The Summer Long Term Emergency rating shall be 580 MVA.
- 2.4 Zero Sequence Loading: It is expected that a simultaneous zero sequence loading of 1½% will occur with a loading of 448 MVA positive sequence. The Seller shall guarantee that the winding temperature rise will not exceed 65°C with this combined positive and zero sequence loading.

### 3.0 Angular Displacement

The autotransformer shall be suitable for operation with the high/low voltage neutral terminal solidly grounded in accordance with the following vector diagram.



4.0 Additional Full Capacity Taps (Refer to PART B, SECTION II, Item 11)

	<u>Winding</u>	<u>DETC Taps</u>
4.1	High Voltage	<u>362,250 – 353,625 – 336,375 - 327,750</u>
4.2	Low Voltage	<u>None</u>
4.3	Tertiary Voltage	<u>None</u>

5.0 Winding Insulation

	<u>kV BIL</u>
5.1	High Voltage Line Terminals <u>1050</u>
5.2	HV / LV Neutral Terminals <u>110</u>
5.3	Low Voltage Line Terminals <u>450</u>
5.4	Tertiary Voltage Line Terminals <u>110</u>

6.0 Impedance (Performance guarantee :To be within +/- 5%)

- 6.1 7.45 % at 268 MVA, and 345 to 115 kV
- 6.2 44.8 % at 268 MVA, and 345 to 24 kV
- 6.3 35.2 % at 268 MVA, and 115 to 24 kV

7.0 Positive and Zero Sequence Equivalent Circuit

See Figure 7 at the end of this Part.

8.0 Sound Level (Performance guarantee)

The autotransformer guaranteed sound level shall be as follows

8.1 ONAN

8.2 1<sup>st</sup> Stage Cooling:

8.3 2<sup>nd</sup> Stage Cooling:

9.0 Losses (Performance guarantee)

Load, No Load, and Auxiliary Losses shall be guaranteed separately as indicated under the conditions listed below. If Seller is unable to meet these individual performance guarantees, Seller shall pay Purchaser liquidated damages based on the following values:

No-Load Losses - \$3000 / kW  
Load and Auxiliary Losses - \$1700 / kW

9.1 Load loss at 85°C: 257 kW at ONAN rating.

9.2 No-Load loss at 20°C: 106 kW at 100% rated kV and frequency.

9.3 Auxiliary losses: 15 kW at 448 MVA rating.

10.0 Bushings (Refer to SECTION II PART B, Item 14)

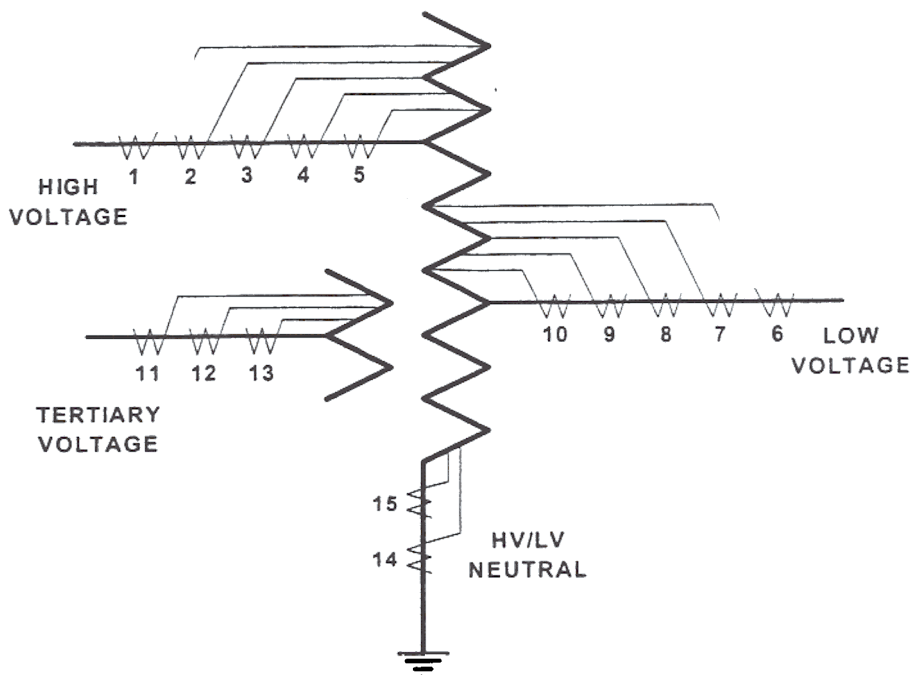
		<u>KV</u>	<u>BIL</u>
10.1	High Voltage Line Terminals (H1, H2, H3)	<u>345</u>	<u>1175</u>
10.2	Low Voltage Line Terminals (X1, X2, X3)	<u>115</u>	<u>550</u>
10.3	Tertiary Voltage Line Terminals (Y1, Y2, Y3)	<u>25</u>	<u>150</u>
10.4	High & Low Voltage Neutral Terminal (H0X0)	<u>25</u>	<u>150</u>

11.0 Bushing Current Transformers (Refer to SECTION II PART B, Item 15)

	<u>Location</u>	<u>Position**</u>	<u>Qty.</u>	<u>Ratio</u>	<u>MR / SR*</u>
11.1	High Voltage	1	3	2000:5	MR
11.2	High Voltage	2	3	2000:5	MR
11.3	High Voltage	3	3	2000:5	MR
11.4	High Voltage	4	3	2000:5	MR
11.5	High Voltage	5	3	600:5	SR
11.6	Low Voltage	6	3	3000:5	MR
11.7	Low Voltage	7	3	3000:5	MR
11.8	Low Voltage	8	3	3000:5	MR
11.9	Low Voltage	9	3	3000:5	MR
11.10	Low Voltage	10	3	2000:5	SR
11.11	Tertiary Voltage	11	3	5000:5	MR
11.12	Tertiary Voltage	12	3	5000:5	MR
11.13	Tertiary Voltage	13	3	800:5	SR
11.14	HV/LV Neutral	14	1	1200:5	MR
11.15	HV/LV Neutral	15	1	1200:5	MR

\* MR = Multi-Ratio, SR = Single Ratio

\*\* CT positions are specified in the following diagram



**Bushing Current Transformer Position Diagram**

**12.0 Surge Arresters (Refer to SECTION II PART B, Item 16)**

**12. High Voltage Line Terminals:**

276 kV duty cycle, 220 kV MCOV, Station class metal-oxide surge arrester mounted adjacent to each 345 kV line bushing.

**12.2 Low Voltage Line Terminals:**

96 kV duty cycle, 76 kV MCOV, Station class metal-oxide surge arrester mounted adjacent to each 115 kV line bushing.

**12.3 Tertiary Voltage Line Terminals:**

27 kV duty cycle, 22 kV MCOV, Intermediate class metal-oxide surge arrester mounted adjacent to each 24 kV line bushing.

**13.0 Auxiliary Power Source**

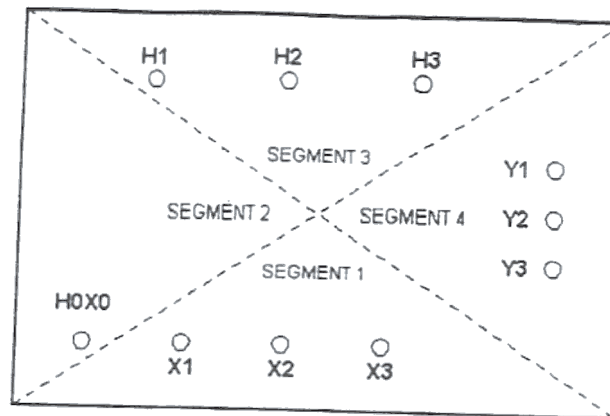
**13.1** 208 Grd.Y/120 Volt, three-phase, four wire, 60 Hz ac power source will be provided by the Purchaser for the unit.

**13.2** Annunciator control voltage shall be 125 volts dc.



#### 14.0 Bushing Arrangement

The Seller shall position the bushings in accordance with the following diagram:



Autotransformer Bushing Layout with Tertiary Winding

#### 15.0 Additional Requirements

The autotransformer shall also be suitable for installation on an existing foundation. Refer to Figure 15.1 for details.

##### Autotransformer Design Limitations

- 15.2.1 Control Cabinet Location: Segment 4.
- 15.2.2 Radiator Location: Segments 1, 2, and 3.
- 15.2.3 Autotransformer Dimensional Limitations: See Figure 15.2.3
- 15.2.4 Transformer shipping height shall not exceed: 14'-6".

- 15.3 The use of internal Metal Oxide Varistors (MOV's) for winding surge protection is not allowed unless authorized by the Purchaser.